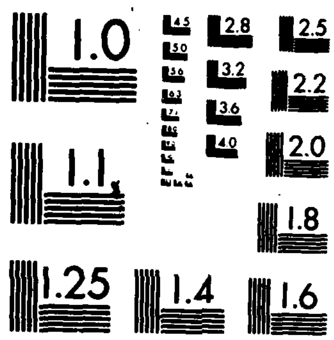
AD-A137 781 PHYSIOLOGICAL ADJUSTMENTS TO HEMORRHAGE ALTITUDE AND WORK(U) CALIFORNIA UNIV SANTA BARBARA INST OF ENVIRONMENTAL STRESS S M HORVATH OCT 83 1/1

UNCLASSIFIED AFOSR-TR-84-0019 AFOSR-78-3534 F/G 6/19 NL

END
FILMED
3-84
DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

ADA137781

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

(2)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: AFOSR-TR- 84-0019	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): PHYSIOLOGICAL ADJUSTMENTS TO HEMORRHAGE, ALTITUDE, AND WORK	5. TYPE OF REPORT & PERIOD COVERED: Final Scientific Report 12-01-77/6-30-83
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): Steven M. Horvath	8. CONTRACT OR GRANT NUMBER(s): AFOSR-78-3534
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Institute of Environmental Stress, University of California, Santa Barbara, CA 93106	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 61102F 2312/AI
11. CONTROLLING OFFICE NAME AND ADDRESS: AFOSR (NL), Bolling AFB, DC 20332	12. REPORT DATE: OCT 83
	13. NUMBER OF PAGES: 14
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

DTIC SELECTE FEB 1 3 1984 S D E

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

exercise, cold and hot environments, hypoxia, toxicological substances, sleep and psychological stresses.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

See Reverse.

DTIC FILE COPY

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

Abstract

This ~~The Institute~~'s research program has been concerned with evaluating the influence of various stressors, physiological and psychological, on man and subsequently determining the capacity of the individual to successfully adapt to these environmental influences. In the process of these investigations some 42 peer-reviewed manuscripts were published. They have dealt with the responses to exercise, cold and hot environments, hypoxia, toxicological substances, sleep and psychological stresses. The subjects for these studies have included both sexes. In general while some facets of man's adaptability have been resolved, it is clear that numerous problems remain to be investigated. New questions have been raised consequent to the studies reported. We trust that in the future the research programs previously supported by the Air Force Office of Scientific Research will again be initiated in order to fully appreciate and utilize man's potential to successfully compete in the environmental conditions present not only at this moment but in the future.

AFOSR-TR- 84-0019

Controlling Office: USAF Office of Scientific Research/NL
Bolling AFB, D.C. 20332

October 1983

Final Technical Report

on

Air Force Office of Scientific Research, Air Force Systems Command

Grant No. AFOSR-78-3534

PHYSIOLOGICAL ADJUSTMENTS TO HEMORRHAGE, ALTITUDE, AND WORK

By

Steven M. Horvath
Principal Investigator

Institute of Environmental Stress

c/o Regents of the University of California

University of California, Santa Barbara

Santa Barbara, California 93106

Work Performed

December 1, 1977 through August 31, 1983

84 02 10 113

FINAL REPORT
ON AIR FORCE OFFICE OF SCIENTIFIC RESEARCH
GRANT AFOSR 78-3534

(December 1, 1977 through August 31, 1983)

The Institute of Environmental Stress has been pleased to have had support from the Air Force Office of Scientific Research. During the five year tenure of this grant we have been able to publish 42 peer-reviewed manuscripts. Twenty-two of these have dealt with the physiological and biochemical responses to environmental stressors, ten have evaluated psychological factors, seven considered responses to toxicological agents, two were concerned with new techniques and one was an extensive review article. Overall the intent of the research program was accomplished although the number of questions raised by our research findings clearly indicate that our knowledge and appreciation of man's potential to respond and adapt to stressors is incomplete and that further research is necessary and would provide productive information.

The research publications resulting from AFOSR support is attached as Appendix 1. The titles of the publications indicate the general trend of the research performed. It would not be possible to evaluate each publication in detail and the summary given below will only highlight some of our findings. The summary will in general follow the pattern of the publications as noted above. I should note that these publications have been requested by both military and civilian scientists and that we (as a staff) have given numerous presentations to various audiences. It is appreciated by the staff that this support has also been of value to our graduate students. Their involvement in the research programs has been effective. Some seven students have received their Ph.D. degrees under the program. Two of them are associated with military laboratories and the others are moving rapidly up the academic ladder.

Our research activities were based on the premise that the human's adaptative potential to stressors could best be evaluated by determining the

physiological, biochemical and psychological alterations of individuals exposed to the combined load of multiple stressors. Although it was necessary to initially evaluate the mechanism involved under the rigorous conditions of a single stressor, the ultimate answers could only be obtained when subject's responses and adaptations are known, understood and related to the naturally occurring situation wherein several stressors impact on the organism.

An extensive review of the physiological changes occurring in man exercising in cold environments provides information of value to the Air Force in determining the potential impact on men operating in such environments. This exercise and cold manuscript delineates the factors that modify thermoregulatory and circulatory adjustments as a result of exposure to low ambient temperatures as well as the significance of the development of a hypothermic state on man's performance and survival. We bring into perspective the incidence of hypothermic deaths as related to rest and work in low ambient conditions as they are influenced by the aging process. Several of our studies on individuals working in cold have been published and add further information as to the adaptability of men (trained in different environments) to a cold stress.

We have made numerous investigations on exercise performance. One such study was concerned with the need for and the potential benefits of a preliminary warm-up on work performance. We concluded that although warm-up might be useful for tasks in which the initial work loads are maximal or supramaximal, it is of questionable value in endurance tasks which begin at a high but submaximal intensity. We were also concerned with the question of the efficiency at which work is performed when someone ele determines the <u>pace</u> at which work is performed. We also evaluated changes in the electrocardiogram of individuals who performed high-intensity respiratory strains such as would occur in situations where individuals fix their thoracic cage. We found a high incidence of "wandering pacemaker."

Application of Institute-developed techniques designed to measure the response of the adrenal-sympathetic nervous system to psychological and physical stressors has been made. These approaches have led to a better appreciation of the levels of strain placed on man. Physiological, biochemical, and thermal responses to long-term work at either modest (30% maximum aerobic capacity) or severe (80% maximum aerobic capacity) levels were made. Major emphasis was placed on the recovery from such levels of activity and the results suggest that recovery of all parameters may not occur for several days post activity.

Studies on the combined stressors of work and anoxia were conducted on both men and women. These studies indicate clearly that women are capable of performing 2 hours of moderate work at altitude up to 523 Torr as efficiently or slightly more so than men. We have conducted studies on exercising women exposed to three different altitudes, 758, 586 and 523 torr. The higher altitudes bracket the altitudes of the Air Force Academy. The percent decrement in maximum aerobic capacity while performing such maximum work at higher altitudes is similar in both men and women, clearly indicating that the combined stresses of work and altitude result in equivalent physiological changes. Women can work for extended periods of time at the same relative efficiency as do men if the work loads are carried out at equivalent levels of respective maximum capacities. This does not imply that the absolute amount of work accomplished will be equal, since maximum capacities of the two sexes are different. However, it is becoming evident based on our present determinations of maximal power of women, that due to the increased activity of women their maximal capacities are increasing dramatically, many of them being in the range of 60-70 ml/kg/min oxygen uptake. These levels are comparable to those determined on some men and better than found in many other men.

We completed additional studies on the influence of "warm up" prior to exercising at various intensities of exercise up to maximum. It is apparent

that some doubts can be expressed as to the physiological value of such preliminary activity on the eventual performance at higher levels of work. Since this was a rather controversial area, we intended to look more completely into the mechanisms involved. We began studies relating preferred work levels to physiological changes. Data from these studies suggested some significant differences in mechanical efficiency as work levels are forced or allowed to proceed at selected preferred levels.

We performed a series of studies to describe the alterations in plasma due to exercise, change of position, and thermal stress. Plasma volumes are altered by simple positional changes as well as by performing exercise in different positions i.e., upright, low sit, and supine. Plasma volume decreases were observed during the change from a supine to an erect posture. Stability of plasma volume following change in posture requires some 20-30 minutes in the new posture. Maximum shifts in plasma volume [resulting from exercise (max) and various combinations of hot exposure and exercise] are approximately 20 percent. This loss of plasma results in a marked reduction in circulating blood volume. The impact of the increased blood viscosity on the circulatory system is evident. We have also investigated the question as to whether or not hypoxia (which is said to alter capillary permeability) with or without additional stress of exercise would alter the pattern of plasma volume shifts. Exercising at high altitudes induces shifts in plasma volumes similar to those found at sea level. Other studies of individuals exercising at high altitudes were conducted with particular reference to the effects of carbon monoxide.

One study is of particular relevance to Air Force operations since it concerns itself with the physiological responses of individuals both resting and working in the heat (49.5°C dry bulb and 28.9 torr vapor pressure). Additionally it addresses the important factor of posture i.e. whether individuals are in the upright posture, in a semierect posture (as in a plane)

or supine. The time course of whole-body sweating and thermal regulation during rest and exercise in three body positions (30 and 45% $\dot{V}O_2$ max) was investigated. Exercise was performed in the upright, low sit, and supine positions (the latter two positions are approximately related to the position of pilots in their planes). Body temperatures were highest in the supine and lowest in the upright posture. Body posture did not modify total sweat production but the percentage of evaporated sweat varied.

The relative percentages of total sweat evaporated were 65, 51, and 46% respectively for the upright, low sit, and supine positions. Furthermore, we observed that evaporative heat loss was not 100% effective in cooling the skin surface area, since sweat probably did not evaporate from the skin surface directly but from the surface of the sweat layer accumulated on the skin.

Thermal balance and load are markedly influenced by the posture during which exercise, even at a light level, is being performed. The greatest increases in body temperature are seen in the supine position and the least in the upright postures. This can be accounted for by the marked reduction in evaporative sweat in the supine position. Whether or not this may become an important factor in pilot operation remains to be determined under actual conditions. It is our impression, however, that more attention will need to be given to the combined effects of exercise, that and assumed posture. There are no marked differences in response during rest periods in the hot environment except for alterations in evaporative sweat rates which are influenced by posture being, as expected, greater in the upright position where a greater body surface area is available for evaporation. Plasma volume shifts are markedly influenced by changes in posture. Further, plasma losses occur if exercise is superimposed, i.e. if exercise is performed in different postures. However, it appears that there is a maximum loss that can occur. Interestingly, the total amount lost is approximately one quarter of the total plasma volume. The impact

of such losses on performance have not yet been determined although some suggestive data indicates that this may not present a problem. Apparently the maintenance of an adequate oxygen transport (since erythrocytes are not lost) provides adequate adaptation. The only remaining concern is the impact of the increased blood viscosity on the functioning of the heart. Since the amount of plasma in the circulating blood volume is modified by posture alone, this observation has some interesting clinical import. It clearly suggests that measurements of plasma constituents could be in error depending upon the posture of the patient at the time of blood sampling as well as the time in that position prior to the blood sampling. Variations of concentration in plasma constituents could be in excess of 16 percent. Such variability can be of significance in certain clinical situations.

One aspect of our research was concerned with the effects of two types of exhaustive exercise on nocturnal sleep and cardiovascular functions. Subjects performed (a) maximal work which can be completed in 20-25 minutes, and (b) submaximal (50-75% of maximal effort) work of 3-4 hours duration. Each subject sleeps four nights - an adaptation night (just instruments and information recorded but not used), a baseline night, an exercise night, and a recovery night. This regime requires a total of eight nights for each subject.

We have completed evaluating the effects on nocturnal sleep patterns of an acute bout of high-intensity exercise (50-75% of $\dot{V}O_2$ max), carried to the point of volitional exhaustion. Five female and four male subjects participated for four consecutive nights, with exhaustive exercise performed on the afternoon of day 3. Subjects were moderately active and moderately fit (mean $\dot{V}O_2$ max = 46.8 ml/kg).

The exercise intervention evoked marked effects on the quantity and temporal distribution of SWS (stages 3 + 4). SWS prior to the first REM period increased from a mean of 31.3 minutes to 47.4 minutes. Stage 4 sleep increased,

as did total SWS. Latency to stage 4 decreased as well. Coupled with the enhanced accumulation of SWS early in the night was a significant increase in latency to first REM onset, a decrease in the length of the first REM period, and a decrease in the length of the first REM cycle. The increases in SWS were largely at the expense of total REM sleep, which decreased significantly after exercise. All of these sleep variables returned to baseline levels on the recovery night after exercise.

The magnitude of the increase of SWS prior to the first REM period was sex-related, with this increase averaging +24.0 minutes for women and, for men, +5.7 minutes ($t_7 = 5.76$, $\underline{P} < 0.001$). Moreover, for women a correlation of 0.85 ($\underline{P} < 0.05$) was observed between this increase and total caloric expenditure (expressed as kcal/kg). In contrast, no apparent correlation was observed in men.

The results suggest that exhaustive exercise affects sleep primarily in the early portion of the night, inducing an increase in SWS "pressure" at the expense of REM sleep. Changes in the duration of SWS prior to REM onset may be the most sensitive indicator of exercise effects on sleep, since this change relates most strongly to total energy expenditure. The sex differences in response to exercise were unexpected but did not seem to be related to differences in exercise performance, fitness, or habitual activity levels.

Impedance cardiography was used to provide measures of heart rate, stroke volume, and cardiac output. These variables were sampled at "lights out" (baseline), sleep onset, and each half hour throughout the night. On the exercise night, heart rate was initially elevated over baseline nights, and remained elevated throughout the whole night. An elevated cardiac output was observed in the early portion of the night, due primarily to the increase in heart rate. These observations are of considerable significance, since on non-exercise nights cardiac output reaches a low point (approximately 40-50%

reduction) at 0300 to 0500 hours. The higher levels observed during exercise nights were unexpected and suggest that an increased cardiovascular load may interfere with successful recovery.

We have also investigated the influence of psychological stress (specifically the response of individuals required to present a seminar to their peers) on the relationship between cardiac output and associated cardiovascular and oxygen uptake. In these situations cardiac output and heart rate increased without an associated elevation of oxygen uptake. This suggested a [illegible]ible dissociation between hemodynamic and metabolic variables. This stud[illegible]as a follow-up of an earlier study in which we found that heart rates co[illegible]attain values approximately 90% of the individuals (coaches) who were simply [illegible]itting while supervising the activities of their respective teams during competitive events. The potential significance of such exceedingly high cardiovascular strain in individuals anticipating various activities in the development of high stress loads is obvious. Further evaluation of these physiological changes can provide significant information on stresses imposed on air crews awaiting an assignment.

Exposure to carbon monoxide at levels postulated to occur in helicopters and in other situations had minimal effects on vigilance. However, such exposure (5% HbCO) significantly decreased the subjects' confidence concerning their performance on the vigilance task. Other reports were concerned with perception of stress--developing a conceptual model of man's responses to environmental stress. The impact of an increased cardiac output and elevated heart rate in what may be considered minor levels of stress was evaluated. It was clearly identified to be associated with psychological parameters and not related to metabolic factors.

We developed new and comprehensive computer systems to evaluate cardiovascular function. This includes two different uses of computer

interaction based on a real-time analysis of events. In the first unit, we have utilized a new display unit (Genisco) which not only records (in multiple color outputs) all circulatory parameters measured but simultaneously calculates a variety of derivative functions. At one-minute intervals, trend plots of the accumulated direct and derived data are displayed. At the conclusion of the experiment, hard copies are immediately available. All data can be checked again at this time and are reviewed for completeness, providing information not available in any other known system. Our second system is an independent microprocessor unit which was designed to obtain circulatory data (and eventually, in combination with another microprocessor being developed, will have all metabolic data also on-line) during exercise. It is postulated that this second system can be eventually developed so that the performance capability of man can be determined easily under field conditions.

It is apparent that we have been most productive not only in the general area of stress responses but in the area relating work performance to the overall physiological and psychological responses and adaptations occurring under a variety of additional stresses. All of our research was based on the concept that man is subjected to multiple stresses and his adjustments to such should be the basis of studies on man under stress.

INSTITUTE OF ENVIRONMENTAL STRESS
PUBLICATIONS AND MANUSCRIPTS
PARTIALLY SUPPORTED BY THE AIR FORCE
UNDER AFOSR 78-3534

PUBLISHED (12/1/77 through 8/31/83):

1. Gliner, J. A., S. M. Horvath, and A. C. Browe. Circulatory changes to alcohol, anxiety, and their interactions. Proc. Soc. Exp. Biol. Med. 14(3): 281-285, 1977.

2. Gliner, J. A., A. C. Browe, and S. M. Horvath. Hemodynamic changes as a function of classical aversive conditioning in human subjects. Psychophysiology 14(3): 281-286, 1977.

3. Borgia, J. F., and S. M. Horvath. Transcutaneous, noninvasive P_{O_2} monitoring in adults during exercise and hypoxemia. Pfluegers Arch. 377: 143-145, 1978.

4. Diaz, F. J., R. D. Hagan, J. E. Wright, and S. M. Horvath. Maximal and submaximal exercise in different positions. Med. Sci. Sports 10(3): 214-217, 1978.

5. Hagan, R. D., and S. M. Horvath. Effect of diurnal rhythm of body temperature on muscular work. J. Therm. Biol. 3: 235-239, 1978.

6. Morimoto, T., S. M. Horvath, and J. F. Borgia. Blood volume and plasma constituent changes in splenectomized dogs consequent to exercise. Jpn. J. Physiol. 28: 323-332, 1978.

7. Rochelle, R. D., and S. M. Horvath. Thermoregulation in surfers and nonsurfers immersed in cold water. Undersea Biomed. Res. 5(4): 377-390, 1978.

8. Wagner, J. A., S. M. Horvath, and T. E. Dahms. Cardiovascular adjustments to carbon monoxide exposure during rest and exercise in dogs. Environ. Res. 15: 368-374, 1978.

9. Drinkwater, B. L., L. J. Folinsbee, J. F. Bedi, S. A. Plowman, A. B. Loucks, and S. M. Horvath. Response of women mountaineers to maximal exercise during hypoxia. Aviat. Space Environ. Med. 50(7): 657-662, 1979.

10. Gliner, J. A., J. F. Bedi, and S. M. Horvath. Somatic and non-somatic influences on the heart: hemodynamic changes. Psychophysiology 16(4): 358-362, 1979.

11. McMurray, R. G., and S. M. Horvath. Thermoregulation in swimmers and runners. J. Appl. Physiol.: Respirat. Environ. Exercise Physiol. 46(6): 1086-1092, 1979.

12. Plowman, S. A., B. L. Drinkwater, and S. M. Horvath. Age and aerobic power in women: A longitudinal study. J. Gerontol. 34(4): 512-520, 1979.

13. Gliner, J. A., J. A. Matsen-Twisdale, S. M. Horvath, and M. B. Maron. Visual evoked potentials and signal detection following a marathon race. Med. Sci. Sports 11(2): 155-159, 1979.

14. Wagner, J. A., D. S. Miles, S. M. Horvath, and J. A. Reyburn. Maximal work capacity of women during hypoxia. J. Appl. Physiol.: Respirat. Environ. Exercise Physiol. 47(6): 1223-1227, 1979.

15. Morton, A. R., L. J. Folinsbee, S. M. Horvath, and B. L. Drinkwater. Reliability and objectivity of closing volume measurements in standing subjects. Aust. J. Sports Med. 12(3): 50-53, 1980.

16. Spitler, D. L., S. M. Horvath, K. Kobayashi, and J. A. Wagner. Work performance breathing normoxic nitrogen or helium gas mixtures. Eur. J. Appl. Physiol. Occup. Physiol. 43: 157-166. 1980.

17. Miles, D. S., J. A. Wagner, S. M. Horvath, and J. A. Reyburn. Absolute and relative work capacity in women at 758, 586, and 523 torr barometric pressure. Aviat. Space Environ. Med. 51(5): 439-444, 1980.

18. Kobayashi, K., S. M. Horvath, F. J. Diaz, D. R. Bransford, and B. L. Drinkwater. Thermoregulation during rest and exercise in different postures in a hot, humid environment. J. Appl. Physiol.: Respirat. Environ. Exercise Physiol. 48(6): 999-1007, 1980.

19. Borgia, J. F., and S. M. Horvath. Reflex cardiac effects of local cutaneous cold exposure in dogs. Am. J. Physiol.: Heart Circulat. Physiol. 239(8): H114-H120, 1980.

20. Wilkerson, J. E., S. M. Horvath, and B. Gutin. Plasma testosterone during treadmill exercise. J. Appl. Physiol.: Respirat. Environ. Exercise Physiol. 49(2): 249-253, 1980.

21. Hagan, R. D., F. J. Diaz, R. G. McMurray, and S. M. Horvath. Plasma volume changes related to posture and exercise. Proc. Soc. Exp. Biol. Med. 165(1): 155-160, 1980.

22. Wagner, J. A., D. S. Miles, and S. M. Horvath. Physiological adjustments of women to prolonged work during acute hypoxia. J. Appl. Physiol.: Respirat. Environ. Exercise Physiol. 49(3): 367-373, 1980.

23. Roche, S., S. Horvath, J. Gliner, J. Wagner, and J. Borgia. Sustained visual attention and carbon monoxide: elimination of adaptation effects. Hum. Factors 23(2): 175-184, 1981.

24. Taguchi, S., J. A. Gliner, S. M. Horvath, and E. Nakamura. Preferred tempo, work intensity, and mechanical efficiency. Percept. Mot. Skills 52: 443-451, 1981.

25. Miles, D. S., D. R. Bransford, and S. M. Horvath. Hypoxia effects on plasma volume shifts at rest, work, and recovery in supine posture. J. Appl. Physiol.: Respirat. Environ. Exercise Physiol. 51(1): 148-153, 1981.

26. Gutin, B., J. E. Wilkerson, S. M. Horvath, and R. D. Rochelle. Physiological response to endurance work as a function of prior exercise. Int. J. Sports Med. 2: 87-91, 1981.

27. Horvath, S. M. Exercise in a cold environment. Exercise Sport Sci. Rev. 9: 221-263, 1981.

28. Gliner, J. A., D. E. Bunnell, and S. M. Horvath. Hemodynamic and metabolic changes prior to speech performance. Physiol. Psychol. 10(1): 108-113, 1982.

29. Horvath, S. M., and R. L. Jackson. Significance of P_{50} under stress. In: Oxygen Transport to Human Tissues, J. A. Loeppky and M. L. Riedesel (eds.). New York: Elsevier North Holland, Inc., 1982, pp. 305-315.

30. Borgia, J. F., P. M. Nizet, J. A. Gliner, and S. M. Horvath. Wandering atrial pacemaker associated with repetitive respiratory strain. Cardiology 69: 70-73, 1982.

31. Wilkerson, J. E., S. M. Horvath, B. Gutin, S. Molnar, and F. J. Diaz. Plasma electrolyte content and concentration during treadmill exercise in humans. J. Appl. Physiol.: Respirat. Environ. Exercise Physiol. 53(6): 1529-1539, 1982.

32. Marcus, R. R., V. D. Ceder, J. F. Borgia, and S. M. Horvath. Computerization of a cardiac catheterization lab using a PDP-11/60 with an LPA-11. Proceedings of the Digital Equipment Computer Users Society, Anaheim, December 1982, pp. 203-209.

33. Bunnell, D. E., W. Bevier, and S. M. Horvath. Effects of exhaustive exercise on the sleep of men and women. Psychophysiology 20(1): 50-58, 1983.

34. Marcus, R. R., and S. M. Horvath. Automated limb blood flow plethysmograph. Am. J. Physiol. 244 (Heart Circ. Physiol. 13): H413-H416, 1983.

35. Bunnell, D. E., W. C. Bevier, and S. M. Horvath. Nocturnal sleep, cardiovascular function, and adrenal activity following maximum-capacity exercise. Electroencephalogr. Clin. Neurophysiol. 56: 186-189, 1983.

MANUSCRIPTS IN PRESS (as of 8/31/83):

1. Avakian, E. V., R. B. Sugimoto, S. Taguchi, and S. M. Horvath. Effect of panax ginseng extract on energy metabolism during exercise in rats. Planta Med.

2. Borgia, J. F., S. M. Horvath, and R. A. Sorich. Persistent myocardial ischemia following chronic hyperoxia in conscious dogs. J. Thorac. Cardiovas. Surg.

3. McMurray, R. G., S. M. Horvath, and D. S. Miles. Hemodynamic responses of runners and water polo players during exertion in water. Eur. J. Appl. Physiol. Occup. Physiol.

4. Wagner, J. A., K. Matsushita, and S. M. Horvath. Effects of carbon dioxide inhalation on physiological responses to cold. Aviat. Space Environ. Med.

ADDITIONAL MANUSCRIPTS SUBMITTED (prior to 8/31/83):

1. Gliner, J. A., and G. S. Gliner. Perception of stress: Multidimensional scaling of environmental stimuli. Environ. Behav.

END

FILMED

3-84

DTIC